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ABSTRACT

The report discusses 12 research projects on hearing impairment undertaken at the Gallaudet Research Institute. The institute focuses on three major categories of research areas: accommodation to hearing loss, prevention of hearing loss, and restoration of hearing. Following a brief description of the functions of the Office of the Vice President for Research, 12 research reports are presented. Each project is summarized, its principal investigators listed, and major findings noted. Studies touch on the following topics: psychotherapy as treatment for depression in deaf individuals, social/emotional assessment of deaf children, simpler sign forms for children with various handicaps, non-manual behaviors in sign language, a dialogue journal writing project, narrative schemata in hearing impaired readers, interpretation of achievement test scores, revision of the Stanford Achievement Test-Special Edition, a decade of the annual survey of hearing impaired children and youth, state surveys, the autocuer, and effectiveness of cochlear implants. Thirty-three additional research projects conducted during 1981-82 are listed. (CL)

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Gallaudet Research Institute

Progress in Deafness Research 1981—82

Published by the Division of Research, Gallaudet College

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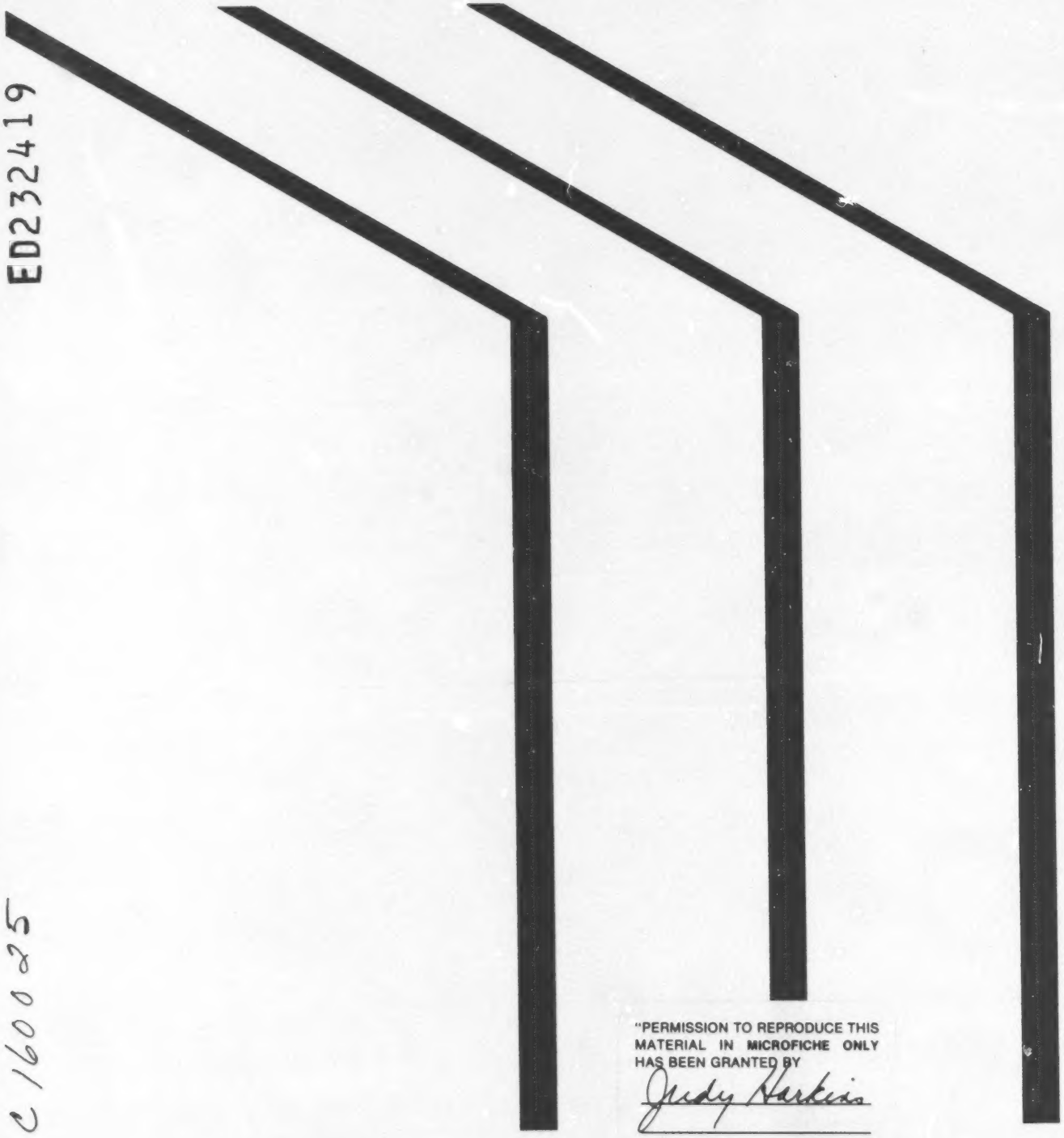

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Gallaudet Research Institute

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Introduction

Raymond J. Trybus
Dean of the Gallaudet Research Institute

Why This Report?

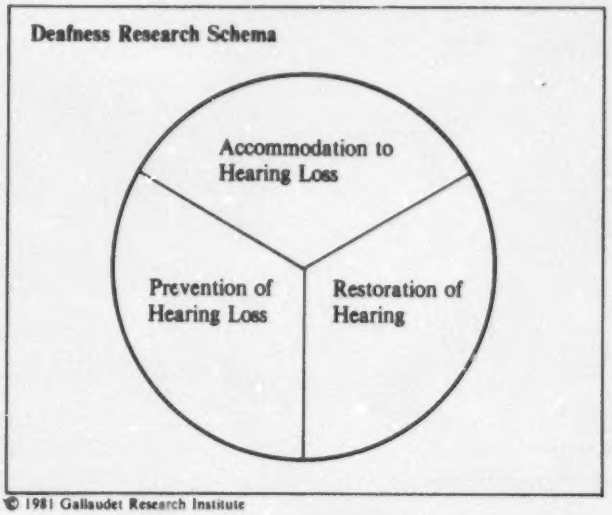
Our reason for putting together this report is to keep you, our public, informed as to our progress in the area of deafness research. Our work is directed towards a major public concern, the impact of hearing impairment on people and on society, and it is supported by public funds; therefore we have an obligation to report to the public on our progress on their behalf.

Our intention is to produce a progress report of this kind from time to time, so as to keep in touch with you. To complete the keeping-in-touch cycle, we invite comments, suggestions, criticisms, and questions from our readers. You may feel free to direct your communications to the researchers in question if your interest is in a particular project or line of research. If you would like to comment on the entire research program, or on other matters of general interest, please feel free to refer your questions to me.

The research activities described in this publication are a selection of the many projects currently underway. We have not attempted to encapsulate every project, but instead have selected a representative sample of studies to describe in some detail. The work presented here is mostly that of projects which have been completed, but in several instances we have decided to report on work now in progress, because we think it has particular interest and relevance to major issues in our field.

Future Directions of the Gallaudet Research Institute

Four years ago, Gallaudet College decided to consolidate its various research units and programs, which previously had operated quite independently of each other, into the Gallaudet Research Institute. The underlying purpose of the Institute is to focus and unify Gallaudet's research effort. Much of the work of the previous research units was very valuable, even definitive in some cases. Nevertheless, the clear conclusion was that, in an era of limited resources, a unified and better focused research program was essential to making any significant progress in posing and resolving major questions in deafness research.



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We began by conceptualizing the totality of deafness research, in order to target those pieces of the totality which we believed were most in need of research attention and most within our capabilities as an institute. Accordingly, we have developed the "deafness research schema" which appears in Figure 1. The three major portions of this schema are: (1) research aimed at the prevention of hearing loss; (2) research aimed at the restoration of hearing or some functional equivalent; (3) research devoted to accommodation to or living with the fact of hearing impairment. Within each of these three broad areas—prevention, restoration, accommodation—a number of major research issues have been delineated. Others might perhaps divide the pie a bit differently from the way we have done here, but the key element is having a comprehensive view of the needs and possibilities in deafness research as a means

for appropriately selecting research emphases as time goes on. Within this broad schema, we have selected the following three goals to which we plan to give particular attention in the years immediately ahead:

1. To assist deaf people in improving their reading and writing abilities beyond the "fourth grade plateau" which now characterizes deaf young people upon the completion of elementary and secondary education;
2. To improve communication in both directions between deaf persons and the other 99% of the population; and
3. To reduce the occupational and income "penalty" associated with deafness.

As is apparent, most of the work which will be conducted in response to these three goals will be in the area of accommodation to deafness, which has been the characteristic focus of our research activities in the past. Some of the work in the area of improving communication, however, goes to the issue of restoration, since communication between deaf persons and others can probably best be improved by restoring hearing or by providing a functional equivalent of hearing through such means as electronic hearing and vibrotactile stimulation.

Among the reports in this document which relate to the improvement of reading and writing abilities are the study by Knight on the internal concepts deaf readers have of the structure of the stories they read; the work of Stokoe with the interactive writing of the dialogue journal kept between students and their teachers; and the work of Allen, White, Karchmer, Schildroth, and Rawlings with respect to the description of hearing impaired children in special education programs and the measurement of their achievement in school.

Four of the reports are devoted to various aspects of improving communication. Bornstein's work on simplified signs is designed to improve the communication of families and teachers with multiply handicapped hearing impaired children, as well as with other severely handicapped children who are unable to communicate by speech and hearing, even though they are not deaf. Baker-Shenk's recent work has generated some provocative hypotheses about the functions of non-manual behavior in sign language communication. A potentially significant contribution to the improvement of communication between deaf and hearing people is found in Cornett's work on the Autocuer, a device now in the developmental stage which automatically provides a set of visual cues to supplement speech reading at those critical junctures at which groups of different sounds cannot be differentiated on the lips alone. MacFarland's work on the Cochlear Implants is part of our research program in the area of rehabilitation engineering, and describes one of the promising new avenues for potential restoration of some usable hearing to deaf individuals.

Less of our work to date has focused on the third goal, that of reducing the occupational and income penalty of deafness, and accordingly less of what is reported here relates directly to this goal. Mental health has often been defined as the ability to love and to work. Impairments of mental health, therefore, typically result in impaired ability to love and to work. As a result, one of our recently initiated research programs has been in the area of improving mental health services to deaf individuals, and in particular to the psychotherapy of depression in deaf individuals. As Brauer explains in her report, this work is being conducted in close parallel with a major national collaborative study of the psychotherapy of depression being conducted by the National Institute of Mental Health.

As the Gallaudet Research Institute increasingly achieves the unification and better focusing of research, we hope and expect to see increasingly important and useful products, methods, materials, and understandings, all of which are aimed at improving the quality of life of our society by preventing hearing loss, restoring hearing, and by better accommodating to the existence of hearing loss among ourselves.

Organization of This Report

This progress report begins with a brief description of the administrative services provided by the Vice President for Research and his staff, both in support of the Gallaudet Research Institute and in support of other research and related activities within the Gallaudet College community. Following this summary, the various research reports are presented. Throughout this publication appear the names of our investigators and supporting personnel, members of our Scientific Advisory Board and of the College's Board of Trustees and Central Administration, as well as a listing of the other research activities not described in detail in this report. For those wishing to pursue some of these issues in greater detail, we have enclosed a listing of the publications and scientific presentations of our personnel, as well as a listing of that all-important group, the sponsors of our research.

The purpose of research is to answer questions and solve problems, of course, but an even more important purpose of research is to challenge, to stimulate, and to provoke ourselves and others to question our assumptions, our accepted ways of thinking and doing, and to attempt to reformulate the challenges facing us in newer and more productive ways. Therefore, while we hope that our work has helped to answer some of your questions, we hope even more that we have succeeded in questioning some of your answers. Please let us know if we have succeeded.

Office of the Vice President for Research

Administration and service are the two major thrusts of the Office of the Vice President for Research. In addition to central administration, planning, and fiscal management of the Division, the Vice President oversees a number of ancillary services to the College as a whole and to the field of deafness.

Service to the College

Like most colleges and universities, Gallaudet actively encourages faculty and staff to seek funding from outside sources. The Research Division supports these efforts through its Office of Sponsored Research. Office personnel assist College faculty and staff in identifying sources of funding; conceptualizing a project that would both satisfy requirements of the funding source and benefit deaf persons; designing a well-organized and manageable project; and producing a proposal of high quality. Federal, state and local funding agencies are the primary target of the office, but staff also work cooperatively with the College's Development Office, which seeks private funding opportunities.

During the past year, the office provided technical support in the development of 21 new Gallaudet proposals, and post-award assistance to 19 projects. Ordinarily, the office limits service to Gallaudet personnel only. This year, however, the staff also assisted several outside agencies and organizations in developing proposals that promise to advance the causes of deaf people.

In this time of increasing competition for federal dollars, particularly in higher education, Gallaudet's proposals were well received. The College proposed a total of approximately $3.6 million, and succeeded in winning awards totalling 43% of the dollar amount proposed. The size of grant ranged from $5,000 to the Audiology Department for a traineeship, to approximately $1.1 million for a three-year award to the Gallaudet Research Institute for a Rehabilitation Engineering Center for the Hearing Impaired. Awards came from ten different funding sources, including such diverse agencies as the Department of Education, the Department of Health and Human Services, the National Aeronautics and Space Administration (through Research Triangle Institute), the Peace Corps, National Endowment for the Arts, National Endowment for the Humanities, National Institute on Aging, Law Enforcement Assistance Administration, National Science Foundation, and three state departments of education.

Proposals Submitted to Federal Funding Sources by Gallaudet College
July 1, 1981 — June 30, 1982

Status	Number of proposals	Dollar amount	Percentage of total
Awarded	5	1,567,655	43
Pending as of 6/30/82	8	1,162,344	32
Not awarded	4	511,206	14
Solicitation cancelled after proposals submitted	4	383,073	11
Total submitted 7/1/81 to 6/30/82	21	3,624,278	100

Another service function of the Vice President's office is stimulation of deafness research at Gallaudet by faculty and staff members outside the Research Institute. One of the most common barriers to campus research is lack of funds for small studies. To encourage campus research, the Office of Faculty and Graduate Student Research, through a competitive award process, distributes small grants for research projects. This year, the office awarded a total of $14,000 to members of the Gallaudet faculty, staff and student body.

Service to the Field

Through the Office of Research Utilization and Publications, the Vice President's office publishes several periodicals and provides leadership in these and other activities aimed at sharing information and promoting the use of research findings. In conjunction with the Gallaudet College Press, the office publishes *Directions,* the professional journal of Gallaudet College. This year, four issues of *Directions* were published, each addressing a single theme related to educational programming for hearing impaired children.

A new endeavor in 1982 was the publication of the

Gallaudet Research Institute Newsletter, distributed to nearly 10,000 agencies, organizations and individuals in the United States and abroad. Several newsletters previously published by the individual units within the Research Institute were incorporated into one, as a cost-saving measure and means of reaching more people with more information. Through the newsletter the Division will keep the field of deafness and related disciplines informed about the diversity of the research programs at Gallaudet.

The Vice President also oversees Gallaudet's involvement in the quarterly *DSH Abstracts*, co-sponsored by the American Speech-Language-Hearing Association. During 1981 and early 1982, the Editorial Board of *DSH Abstracts* has moved toward a new format for the journal, one that would make extensive use of the National Institutes of Health's Medical Library and Retrieval Service through its computerized database, MEDLINE. The change in source and format will enable *DSH* to provide more up-to-date information on a broader range of topics and at lower cost.

The Office of Faculty and Graduate Student Research was instrumental in the coordination of a major conference on sociology research in deafness, a joint effort with the Department of Sociology. The conference, hosted by Gallaudet College in early June, 1982, attracted more than 100 sociology scholars and professionals in deafness and resulted in several volumes of working papers.

Distinguished Professorship

Gallaudet annually awards a one-year professorship, the Powrie V. Doctor Chair of Deaf Studies, to a scholar whose professional interest is in the field of deafness. The Office of the Vice President provides administrative services to the incumbent. The 1981-82 professor, Dr. Robert G. Sanderson, is a nationally recognized leader in the fields of deafness and rehabilitation. Sanderson hypothesized that the social environment affects the deaf person's ability to adjust to the work environment. He surveyed rehabilitation counselors serving deaf clients, and asked them to indicate the kinds of services they provide. Preliminary results support his hypothesis: Counselors are providing a myriad of services only indirectly related to clients' employment.

A recent charge to Gallaudet from its Board of Trustees is that the college grow and develop into a major national research facility. Through the multi-faceted projects directed by this Office in the past year, Gallaudet is making visible progress towards gaining a notable research identity, and thus is well on its way to meeting this charge.

Charles Shoup

The Office of the Vice President for Research assists Gallaudet faculty in designing research projects and awards small grants to support the research of teaching faculty and graduate students.

A Collaborative Study of Psychotherapy as a Treatment of Depression in a Deaf Population

Principal Investigator: Barbara A. Brauer, Ph.D.

As part of the spectrum of human emotions, transient unhappiness follows many of life's disappointments and losses. What distinguishes normal depressed feelings from depressive disorders is that, instead of being transitory, the symptoms of depression last inordinately longer without treatment and cause severe changes in usual function. Depressive disorders are the leading cause of United States hospital admissions for mental illness. An estimated 8 to 20 million Americans currently suffer from depressive disorders. Caring for victims of depression exacts a toll well over $10 billion annually. (Teuting, Koslow, & Hirschfeld, 1981). Ironically, much of the suffering brought on by depression is unnecessary; it breeds hopelessness in many who do not realize they suffer from a very treatable condition.

The prevalence of depression among deaf people is not known, as earlier studies on this issue had conflicting findings (Grinker, 1969; Mindel & Vernon, 1971; Altshuler, 1971). Recent self-concept studies on deaf populations have found below-normal levels of self-esteem and overall low self-concepts (Randall, 1969; Sussman, 1973; Brauer, 1979). Low self-esteem has often been theoretically implicated in depression, and these findings indicate that deaf people may have increased vulnerability to affective illness and experience a higher than average risk of mental health disorders.

There has been much research on various forms of psychotherapy as used with hearing populations. However, the literature on psychotherapy or counseling with deaf clients consists almost exclusively of anecdotal observations and clinical experience, with little data to support the conclusions. Existing studies are inadequate to answer the questions of researchers, clinicians, consumers and the public: Which treatments are the most efficacious, safe, and cost-effective for which mental disorder?

During the past year, the Gallaudet Research Institute was fortunate to join an ongoing, collaborative research program on the treatment of depression. This program, initiated by the National Institute of Mental Health, will compare short-term treatment conditions for outpatients diagnosed as having major depressive disorders. The treatment conditions are: cognitive/behavioral therapy (as developed by Aaron T. Beck and his associates); interpersonal psychotherapy (as developed in the New Haven-Boston Collaborative Depression Project); pharmacotherapy plus clinical management; pill-placebo plus clinical management; and a "treatment-as-usual" condition. Cognitive/behavioral therapy is aimed at correcting the depressed patient's negative view of the self, the world, and the future. Interpersonal therapy is a psychodynamic approach that focuses on the patient's current, rather than past, problems that are related to role disputes and interpersonal difficulties.

Gallaudet will conduct a similar comparative study of the treatment of depressive disorders in deaf people. Because psychiatric symptom expression is culture-specific and because many therapies are effective for some types of patients treated by certain types of therapists, recent efforts have concentrated on improving positive matches between patients and therapists or therapies. In particular, the Gallaudet study will compare the effectiveness of a dyadic, monolingual match (both client and counselor are deaf, or client is deaf and counselor is hearing and fluent in sign language) with a triadic, bilingual match (as when patient is deaf, therapist is hearing but does not know sign language, and an interpreter is used). If successful, a larger collaborative study using a common protocol may be undertaken with several facilities serving deaf clients.

Preliminary work has involved translating several self-report instruments into American Sign Language. On the premise that translation from a spoken language into a signed language is the same process as between two spoken languages, the back-translation procedure was used (Twenty and Hoemann, 1976). This procedure uses two or more bilingual translators, who translate a text from the source language (SL) into a target language (TL). In this case, one translator prepared an initial signed version of the written English text. Another translator then re-translated the ASL version back into English. The two English versions were compared, and the differences taken into account in the preparation of a new sign language version. The cycle (SL to TL to SL) was repeated until both language versions were equivalent.

Here Brauer works with a native signer on the translation of items in a psychological inventory. The resulting sign language version is later "back-translated" (right) into English by bilinguals who have not seen the original instrument.

A previous study supports the concept that, with qualified translation, adaptation of instruments into ASL is possible (Brauer, 1979). Alternate-form reliability coefficients were found to be between .75 to .89 for the subscales and .89 for the total scale of a psychological inventory.

To date, nine instruments are nearing completion in this translation cycle. Next, each translated instrument will be tested for reliability by a variation of the alternate-form reliability estimation procedure. The availability of sign language versions of assessment instruments will obviously have great potential for use, beyond this study, by clinicians. Instruments that have been translated include The Medical Check List (self-report), Hopkins Symptom Check list-90/Depression Scales, Carroll Rating Scale, General Life Functioning Scales, Dysfunctional Attitude Scale, Life Events questionnaire, Barrett-Lennard Relationship Inventory, Beck Depression Inventory, and Tennessee Self-Concept Scale.

A unique aspect of the study will be the standard training given to therapists in the particular treatment approaches to be used. This standardization of therapist training will allow for a more precise definition of treatment conditions and will provide a sounder basis for generalizing across research sites.

The results of this study and the experience gained by its participants will serve as useful guides in the preparation and conduct of future studies with deaf patients, particularly when other forms of appropriate therapies and other categories of mental disorders are to be considered.

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Assessing the Social and Emotional Development of Deaf Children

Principal Investigators: Kathryn P. Meadow, Ph.D. and Birgit Dyssegaard, Ph.D.

In 1980, Gallaudet College published the *Meadow/Kendall Social-Emotional Assessment Inventory for Deaf Students* (SEAI), developed by Dr. Kathryn Meadow in collaboration with Michael Karchmer, Linda Peterson and Lawrence Rudner. To date, more than 8,000 inventories have been distributed to educators and researchers.

The instrument contains 59 items, designed to be completed by teachers or other educational personnel who have close contact with their deaf students. Three subscales, labeled "social adjustment," "self-image" and "emotional adjustment," were identified by means of a factor analysis of more than 2,000 inventories collected for the purpose of developing norms. A manual describes the inventory and its development as well as procedures for administering, scoring and interpreting it. (The manual and inventories are available from the Outreach Unit of Pre-College Programs.)

During the past year, Meadow engaged in three major projects related to the inventory: 1) constructing another form of the inventory suitable for younger deaf children; 2) constructing forms for other populations, including translation into languages other than English; and 3) providing additional data on reliability and validity of the instrument.

Preschool Social-Emotional Assessment Inventory

The original SEAI was designed and normed for deaf children aged seven to 21. Teachers of younger deaf children expressed a need for a similar assessment tool and this expressed need led to the construction of a new version of the inventory.

Meadow's procedure was to develop a bank of items, which were first circulated to educators and mental health professionals for review. This led to the 72-item research edition of the preschool inventory. A total of 53 preschool programs for hearing impaired children in nine states collected information from teachers on the children in their classes. Participating programs also recruited some hearing preschool programs to participate. The total number of inventories collected was 903 for hearing impaired preschoolers and 146 for preschoolers with normal hearing. In addition, repeat inventories were collected for 165 children; 110 represent data for test-retest reliability measures and 55 will yield data for inter-rater reliability measures.

Modification of the SEAI for Other Populations

Dr. Birgit Dyssegaard, visiting scholar at the Gallaudet Research Institute, is on leave from her position as Director of Special Education in Copenhagen, Denmark. Because of her interest in expanding the inventory for use with non-deaf disabled students, Meadow and Dyssegaard designed a modified version of the inventory. Eight items on the original inventory refer specifically to deafness-related behaviors. These items were changed, deleting references to hearing impairments. Several schools or programs for students with learning disabilities were recruited for their cooperation in collecting data on this population. One school in Virginia and three in New York participated in the collection of 97 inventories. Factor analysis will be conducted to determine if the structure is similar to that which emerged for the hearing impaired students. Means computed on the basis of the three scales in the original inventory look similar for the new sample of hearing, learning disabled students and the original deaf group who also have learning disabilities.

Table 1

Mean Score on SEAI

	Social adjustment	Self-image	Emotional adjustment
Deaf, no additional handicaps	3.01	3.09	3.32
Deaf with learning disabilities	2.89	2.84	3.12
Hearing with learning disabilities	2.81	2.71	2.69
Deaf with emotional problems	2.53	2.81	3.07

The original inventory was also translated into Danish by Dyssegaard, and re-translated into English by a bilingual college student unfamiliar with the instrument. The final form emerging from this process was distributed to programs for the hearing impaired in Denmark. To date, 370 completed inventories have been returned (this represents about half of all deaf children in that country).

Additional Reliability/Validity Data

To obtain additional data on reliability and validity of the SEAI, two projects were conducted at Kendall Demonstration Elementary School (KDES) and Model Secondary School for the Deaf (MSSD). The first was an evaluation of a teacher's classroom procedure at KDES. As a part of the study, teachers and counselors completed the SEAI twice, at intervals of three months, on a class of elementary school children. Correlations between teachers' ratings before and after the three-month interval were significant at $p<.05$. The correlation between teachers' and counselors' ratings at time two were significant for social adjustment, but nonsignificant for self-image and emotional adjustment.

In a project at the MSSD inventory ratings were collected from parents, academic advisors and dormitory counselors. Self-image tests were given to the students themselves. To date, the resulting data have been analyzed separately for girls and for boys only. Significant correlations are shown in Tables 2 and 3.

An unexpected finding was that self-image test scores showed negative correlations with standardized achievement test scores.

Table 2

Inter-rater Reliability Correlations

	Subscale of SEAI		
	Social Adjustment	Self-Image	Emotional Adjustment
Girls			
Between mothers' and fathers' ratings	.74	(NS)	.31
Between teachers' and dormitory counselors' ratings	.42	.46	(NS)
Boys			
Between mothers' and fathers' ratings	.68	.55	.33
Between teachers' and dorm counselors' ratings	.45	.56	(NS)

Table 3

Correlations between Students' Own Ratings of Self-image and SEAI Scores

SEAI Scores	Boys' responses on self-image test	Girls' responses on self-image test
Self-image		
completed by dorm counselors	(NS)	.50
completed by father	(NS)	.33
completed by academic advisors (teachers)	.21	(NS)
Emotional adjustment		
completed by dorm counselors	(NS)	.32
Social Adjustment		
completed by teachers	.40	(NS)

All other inventory subscale ratings by teachers, dorm counselors, and parents had non-significant correlations with students' own ratings of self-image.

Simpler Sign Forms for Handicapped Children

Principal Investigators: Harry Bornstein, Ph.D. and I. King Jordan, Ph.D.

Over the last decade, an ever-increasing number of children unable to develop speech have learned signs as a primary means of communication, or as an aid to learning speech. In addition to those who are deaf, a large number of severely handicapped hearing children such as the profoundly retarded, autistic, or cerebral palsied now use signs. Many of these severely handicapped children are able to learn only a very little language, sometimes just a few signs. Generally, they are taught signs in the most laborious fashion—serially, one after another. Very often a teacher must accept an approximation of a sign as the best that can be hoped for. Such approximations are of limited value because they are only understood by one or two teachers.

Certain characteristics of signs might affect rate of learning. These include iconicity (the degree to which a sign resembles that which it represents); the complexity of the movement needed to produce the sign; special features of signs, such as symmetry; and the one that is of prime concern here, sign simplicity. We can regard a sign as simpler if it can be understood even when the usual movement is not made, the usual handshape is not formed, and/or the usual site or location is ignored. If signs were simpler, they might be perceived more readily and/or executed more easily by severely handicapped children. Ease of perception and execution in turn could allow more rapid learning.

To approach these problems, Dr. Harry Bornstein of the GRI and Dr. I. King Jordan of the Psychology Department designed a three-phase project on sign simplification. The project has the following objectives:

1. To determine which of a basic group of highly functional signs could be simplified and yet retain their intelligibility.
2. To test whether simplified signs are more readily executed and/or perceived by children with various severe handicaps.
3. To devise and test strategies of using simplified signs for more effective learning by parents, staff and teachers who deal with severely handicapped children.

To date, the first phase has been completed.

Experimental Instruments

Bornstein and Jordan selected signs for each of the 343 English words most frequently found in 20 manuals used with handicapped children throughout the United States (Fristoe and Lloyd 1980). They made videotapes of a congenitally deaf native signer who produced each sign in three or four simpler versions. In random sequence, each sign was shown (a) without background location (hands only, without head or body) (b) without handshape (formless mittens on the hands) and (c) without movement (in a fixed position). About 80% of these signs do not move significantly from one location to another. For these, the fixed position was in the center of the movement. For the remaining 20% of the signs that do move from location to location, both initial and final locations were used in separate trials. Subjects were permitted seven seconds to write down the English gloss of the presented sign.

Sample and Data Collection

The videotapes were presented to deaf college students at Gallaudet College and the National Technical Institute for the Deaf during the 1980-81 and 1981-82 academic years. Each student wrote down the English gloss for each sign presentation. The researchers obtained 870 free-response protocols. Such students (rather than the target population) were the appropriate test group because the task demands mastery of both sign and English vocabulary.

Analysis and Results

For each of the 343 signs, the researchers computed the percentage of subjects who correctly understood each simplified form of the sign. Signs correctly recognized by 81% or better are characterized as "robust" signs—those that are still easily recognized when simplified. Those correctly recognized by 20% or fewer are thought to be "fragile".

When the location is eliminated, about 36% of the signs were still recognized (i.e. robust); when handshape was eliminated, 17% could be understood; without movement, 16% were understood. In short, there are a substantial number of highly functional signs

that are readily recognizable when simplified—even when there are no situational clues.

The number of robust signs would be still larger if teachers knew which forms are commonly confused with one or more other signs. It is our intention to provide teachers with specific information about these common confusions, as well as additional information about those signs that are unlikely to be understood when poorly executed. The teacher might require higher standards of execution for those signs. A draft of a possible page of these kinds of information is shown below.

The 343 signs have further been characterized on eight "dimensions" (1) handedness (one or two), (2) iconicity, (3) visibility to signer, (4) touch or not touch, (5) symmetry, (6) one or more movements, (7) location, and (8) handshape. Bornstein and Jordan are now analyzing sign intelligibility by each of these eight characteristics. The results may enable us to predict which signs are likely to be robust outside of the present 343 sign corpus or in other sign languages.

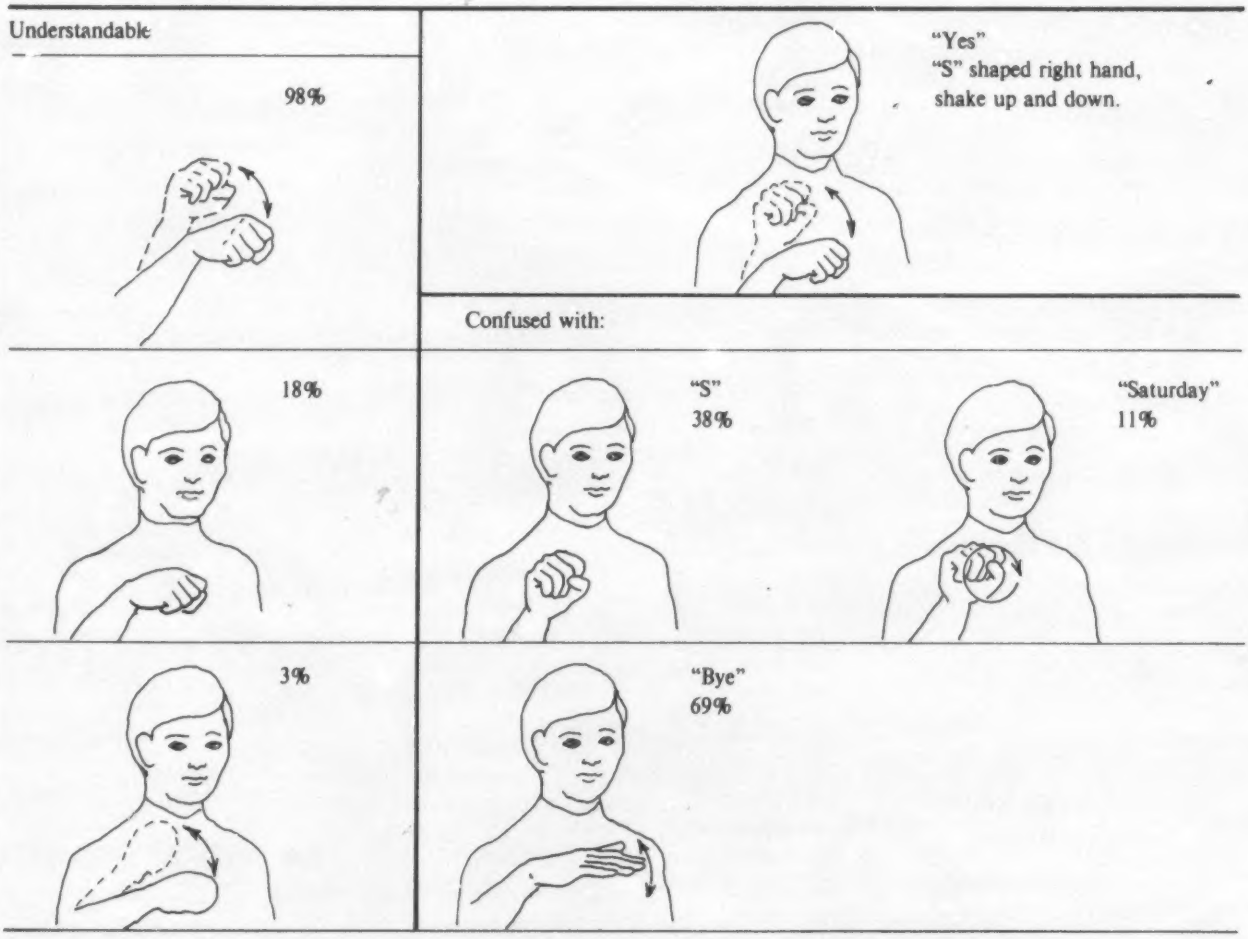
Future Research

The Gallaudet Research Institute has entered into a consortium with the Elwyn Institute and Purdue University along with a number of other sites to determine if use of these simplified signs will indeed increase the sign vocabulary of severely handicapped children. Future studies will attempt to find the optimum sequence and mix of simplified and regular sign forms. For example, teachers could (a) work entirely with simplified forms, (b) model regular forms but accept simplified forms, and/or (c) proceed with regular forms after simpler forms had been mastered. All strategies would be tailored to the needs of the children in order to make for the most effective language learning.

Reference

Fristoe, M. & Lloyd, L.L. Planning an initial expressive sign lexicon for persons with severe communication impairment. *Journal of Speech and Hearing Disorders*, 1980, *45*, 170-180.

Teachers' Instructions on Simpler Sign Forms for Handicapped Learners (sample page)



13

Non-Manual Behaviors in American Sign Language

Principal Investigator: Charlotte Baker-Shenk

Since Stokoe published the *Dictionary of American Sign Language* in 1960, the study of ASL (American Sign Language) has been an ongoing line of Gallaudet research. Charlotte Baker-Shenk observed that movements of signers' eyes, face, head and torso are not random, but perform certain linguistic functions. Based on that observation, she engaged in an exploratory study of non-manual behaviors in ASL. The pilot project, begun in 1978 and funded for more than three years by the National Science Foundation, is now nearing completion.

The source of data for the study has been the videotaped conversations of two pairs (dyads) of native deaf signers. Informants were adults, aged 25 to 30. All were from families in which parents and all siblings were deaf from birth. Educational level ranged from completion of high school to completion of a master's degree.

Approximately one hour of conversation was recorded for each dyad. Baker-Shenk captured the conversations from four perspectives: a closeup view of each signer's face, a split-screen of the two signers' upper torso and face, and a wide-angle view of the full bodies of both signers together. All videotapes were marked at 1/60 second intervals (one number per video-field).

Then began the laborious process of identifying and coding every detail of the non-manual behaviors. Coding of facial movement was based on Ekman and Friesen's Facial Action Coding System (1978), which assigns a number to each facial or action unit. The times of onset (beginning) and offset (ending) of each action were also noted. The intensity (low, medium, or high) of the apex, or peak, of each action was recorded, as were the onset and offset times of the apex. New coding conventions in the form of a timeline recorded the signers' eye-gaze, head, torso, and manual activity. Finally, the sentences in their context were translated into English by two bilingual signers, one deaf and one hearing.

This microscopic analysis has yielded a wealth of information about the role of non-manual behaviors in ASL conversations. Perhaps most importantly, the study results support a tentative hypothesis that these actions are part of the grammar of the language.

In certain types of discourse—questions, negative statements, and conditional clauses, to name a few—non-manual behaviors were employed systematically. Often the non-manual action was the primary or only syntactic clue to the type of sentence. For example, facial action and head movement marked the difference between a sentence containing a conditional statement ("If it rains, I won't go.") and two separate statements ("It's raining. I won't go."). Generally, signers produced the facial actions that act as syntactic markers simultaneously with manual signs. The facial actions increased quickly in intensity to their apex and were performed at medium to high intensity level.

Baker-Shenk observed considerable variation, however, in the combinations of non-manual behaviors occurring within a given linguistic context. Sources of this variation, whether signer-specific or related to the linguistic context of the discourse, will be the subject of future studies.

This research clearly suggests that ASL is a language that systematically and efficiently takes advantage of the many "channels" available—not only the hands and arms.

Reference

Ekman, P., Friesen, W., *Facial action coding system.* Palo Alto, Ca.: Consulting Psychologists' Press, Inc. 1978.

Tom Klagholz

MJ Bienvenu, research assistant, demonstrates syntactic signals in ASL. Left: Manual sign WHO with the syntactic signal for 'wh-' word questions (e.g., Who was that?). Right: Same sign with syntactic signal for rhetorical questions (e.g., And who do you think showed up?). (Photos are from American Sign Language: Teacher's text on grammar and culture. *Silver Spring, Md.: TJ Publishers, Inc., 1980.)*

Dialogue Journal Writing Project

Principal Investigator: William C. Stokoe, Ph.D.

Dialogue journal writing does just what its name implies: It stimulates written conversation between teacher and student. The rules are few and simple:

1. The teacher reads and responds to the student's entry, giving no grade, making no marks, correcting no writing (although the teacher's model often does correctly what the student has tried to do).
2. The turn-around time is as short as possible; student journals handed in at one class period are handed back with teacher response in the next class.
3. The journal is strictly confidential between student and teacher, unless the student gives written permission that the material be used, without identification of writer, for research purposes, and with the proviso that emergent signals (e.g., suicidal overtones) will be responded to appropriately.

There are no rules for the student except the general direction to "keep communicating" in the journal (Staton et. al., 1982).

Dr. William C. Stokoe has begun a demonstration and evaluation study of dialogue journal writing at Gallaudet. The project has a double thrust, in research and instruction. It promises to demonstrate a technique based on sound linguistic principles and to evaluate its effectiveness in improving written English language performance. This study hypothesizes that "students writing to communicate with a thoughtful, caring other, on concerns of their choice and with no overt attention to form, style, or error will within an academic year show marked improvement in every aspect of communication."

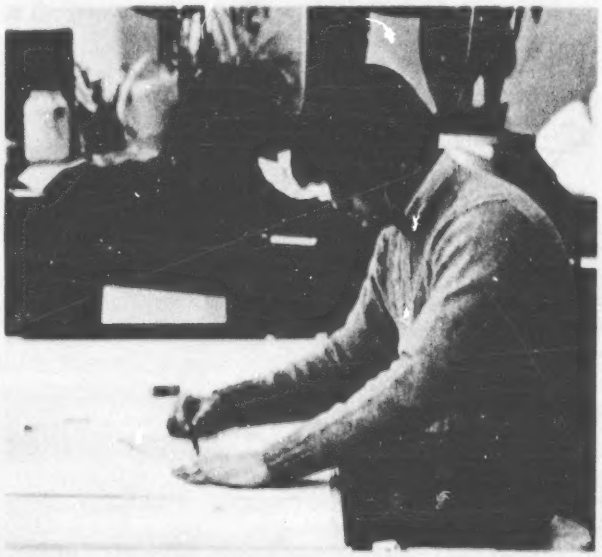
The major activities in phase I of the project have been to acquaint persons in a position to use dialogue journals at Gallaudet with the concept and its operation; to persuade teachers to use the technique and to monitor closely their experiences; and to obtain results that will encourage greatly increased faculty participation in phase II. Ten faculty at Gallaudet and six at the Model Secondary School for the Deaf are now using the method as part of this project. Instructors have observed that the technique yields a wealth of samples of deaf students' writing; students write three lines to one-half page for each class period.

In Phase II, students' journal entries will undergo formal discourse analysis, using a protocol and standards developed by the Center for Applied Linguistics. The technique permits the analysis of not only grammar, form, phrase structure and spelling, but also the content of the writing sample. It enables researchers to rate the coherence of the passage and its relationship to the teachers' writings. The study will also compare length of entries at the beginning and end of the dialogue journal program, and the extent to which students develop a more "compact" style of writing. The "compactness" measure will be "terminal unit ratios," ratios of the number of words between periods to the number of main clauses between periods.

Data collection and analysis will continue throughout the 1982-83 academic year.

Reference

Staton, J., Schuy, R., Kreeft, J. & "Mrs. R." *Dialogue writing as a communicative event*. Arlington, Va.: Center for Applied Linguistics, 1982.



Dialogue journal writing stimulates written communication between teacher and student and provides a wealth of writing samples from which to gauge progress over time.

Narrative Schemata in Hearing Impaired Readers

Principal Investigator: David L. Knight, Ph.D.

During the past ten years, research has pointed to a large gap in reading achievement between deaf and hearing peers. These descriptive studies have done little, however, to reveal how deaf children read, or to account for their reduced level of reading achievement.

Recent study of the reading process used by hearing subjects has resulted in theories about the cognitive structures that hearing people use. Story grammarians have focused on the written material and the extent to which the stereotypical structure of stories influences reading comprehension. Other researchers have concentrated on the reader, and have described the ways that the reader encodes events, episodes, relationships and sequences in the text.

For a story to be understood, there would have to be a good match between the "story grammar" structure and the reader's internal schema for processing stories. Although research supports this notion, it has been difficult to design studies that measure subjective story structure.

The research of Dr. David Knight has compared the subjective story structures of hearing and hearing impaired subjects. Earlier work (Knight and Yekovich, 1981) indicated that hearing impaired subjects seem to use a different internal organization of the story constituents. The method of this previous study was to have undergraduate students sort simple story propositions (roughly the equivalent of simple sentences) into cohesive story units. The resulting clusters were then analyzed using hierarchical cluster analysis, and from this analysis, researchers drew conclusions about the students' subjective story structures.

A problem with interpreting this study is that, because of the nature of the task, subjects may have depended on their knowledge about syntax and linguistic markers to organize the propositions. If so, differences in knowledge of English grammar would account for the different performances of the hearing and hearing impaired groups. Another possible explanation is that hearing and deaf students differed on their definitions of "normal" story order.

A more recent project carried this line of research one step further. As in the previous study, subjects sorted propositions into story clusters, but did so under two conditions. Some of the stories were presented in the usual ("canonical") story order while others were scrambled. Subjects were 164 college students of whom half were deaf and half were hearing. The deaf students had a hearing loss of 80 dB or greater in the better ear, were prelingually deafened, and had English-speaking hearing parents.

The written material consisted of four simple stories with well known structural properties (Mandler and Johnson, 1977; Glenn, 1978). Both groups were required to 1) sort sentences into the most comprehensible story order ("best logical sequence" as worded in the instructions) from stories presented in canonical and in scrambled order; and 2) to cluster sentences into cohesive story units ("sentences that seem to go together to make up parts of the story") from stories presented in canonical and scrambled story order. Each subject manipulated a different story under each of the four conditions. That is, subjects never manipulated the same story more than once nor manipulated a story under a given experimental condition more than once.

Knight hypothesized that the hearing impaired subjects would produce different story orders and different cluster solutions under the scrambled conditions.

Results of the hierarchical cluster analysis showed that hearing impaired students as a group performed similarly to hearing students for ordering and clustering stories presented in the canonical condition. How-

ever, their performance was different from hearing students' on both ordering and clustering when the stimulus material was presented in scrambled order. There was high consensus among the hearing impaired students regarding the configuration of sentences.

In Knight's view, these differences in ordering and clustering resulted in plausible interpretations of the stories. He concluded that the hearing impaired students use different narrative schemata, and that these are one basis for differences (usually described as deficiencies) in reading achievement.

Planned studies will test the hypothesis with other written material, such as expository pieces.

References

Glenn, C.G. The role of episodic structure and story length in children's recall of simple stories. *Journal of Verbal Learning and Verbal Behavior*, 1978, *17*, 229-254.

Knight, D.L. and Yekovich, F.R. *Subjective story structure in hearing impaired adults.* Paper presented at the meeting of the American Educational Research Association, Los Angeles, April 1981.

Mandler, J.M. and Johnson, N.S. Remembrance of things passed: Story structure and recall. *Cognitive Psychology*, 1977, *9*, 111-151.

Toward More Appropriate Use of Achievement Test Scores: Applying the Rasch Model

Principal Investigator: Thomas E. Allen, Ph.D.

Educators desire tests that accommodate the special needs of hearing impaired students and, at the same time, provide scores that can be compared with the scores of the students' hearing counterparts. Meeting both of these requirements is a difficult challenge for test designers.

Standardized achievement tests such as the Stanford are constructed to represent the growth patterns and the curricula of hearing students. "Normed" score information may prove of limited value to educators if their deaf students show growth patterns different from those of hearing students, or if the curriculum for hearing impaired students is different.

Current technology in test development allows for the analysis of item response patterns of disparate populations. One such technique is called "Rasch" analysis. Rasch analysis involves the simultaneous assessment of test item difficulty and test taker ability. The product of such analysis is a set of items "calibrated" to a set of test takers. Each item is assessed for its difficulty vis a vis the group of test takers, and each test taker is assessed for his or her ability in relation to the set of items. The items' difficulties and the test takers' abilities are then placed on the same numerical scale.

The Rasch model specifies, a priori, what the relationship should be between a person's abilities and the difficulty of the items. For example, a person whose ability is rated at 25 (the origin of the scale is arbitrary) should have a 50% chance of giving the correct answer to an item whose difficulty is also rated at 25. Given this specification of what the relationship should be between a person's ability and an item's difficulty, it is possible to assess the goodness of fit between the model and a set of test data.

This type of analysis can assist educators in comparing the learning patterns of hearing impaired students with those of hearing students. Once a set of items has been calibrated and judged to satisfy the constraints of the Rasch model with groups of hearing students, the same items can then be administered to a group of hearing impaired students. The items are then calibrated to the hearing impaired group. If the response patterns and calibrations from the two groups match, or "fit," then test scores may be compared.

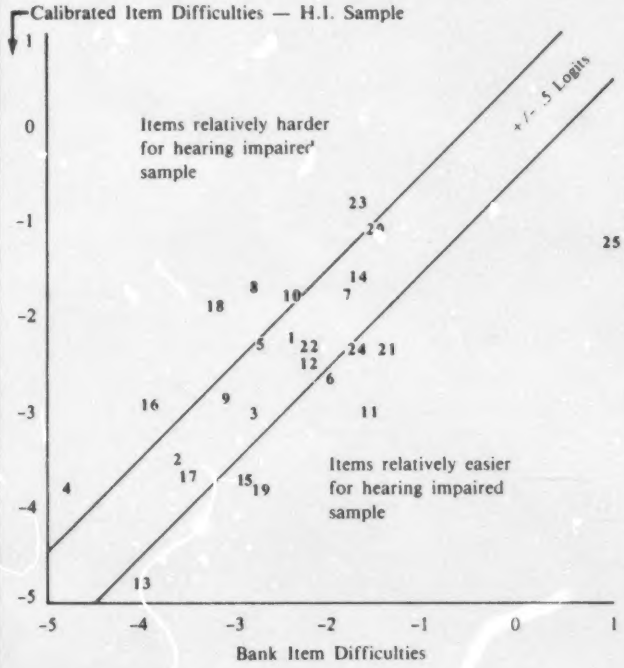
A pilot test and Rasch analysis of a series of language arts tests developed by the Los Angeles County Test Development Center was conducted in spring of 1981. Four levels of a battery of language arts tests were used in the study. The tests measured such language mechanics skills as capitalization, punctuation, prefixes, suffixes, tense, etc. A short screening test assigned the students to one of the four levels of the test. A total of 1,576 hearing impaired students from 39 special education programs in six states were tested.

The hearing impaired students responded to this set of items in a manner quite different from that of hearing students. The statistical procedures revealed that many of the items fit poorly with the item bank developed for hearing children. Some of the items were easier for hearing impaired students and some

were more difficult. These discrepancies are clearly demonstrated in Figure 1, which shows a plot of the 25 item calibrations for hearing impaired students against the calibrations for hearing students.

Figure 1

Plot of bank item difficulties against those obtained for hearing impaired sample — adjusted to bank scale



The analysis also showed that the items tended to bunch together in terms of their difficulty. Hearing impaired students performed either very well or very poorly on most of the test items. Therefore, one cannot draw conclusions from these test scores about the way these language art skills typically develop in hearing impaired students.

The study brought into focus a central problem faced in the adaptation of achievement tests for hearing impaired students. On one hand, educators are pressured into providing test score information that has meaning in a hearing world. On the other hand, hearing impaired students may respond to standardized achievement tests in some subject areas in ways which make the use of comparison tables a dubious practice.

For standardized tests to be useful, educators must know which kinds of comparisons are and are not appropriate. Dr. Allen will conduct an extensive item analysis of the new Stanford Achievement Test items with the SAT-HI norming sample in the coming year.

Revising the Stanford Achievement Test, Special Edition for the Hearing Impaired

Principal Investigators: Thomas E. Allen, Ph.D. and Corinne White, Ph.D.

The 1973 Stanford Achievement Test, Special Edition for Hearing Impaired Students (SAT-HI) is the most widely used instrument in assessing the academic achievement of the nation's hearing impaired children and youth. During the 1981-82 school year, materials for testing upwards of 35,000 hearing impaired children have been distributed. A major ongoing project of Dr. Thomas Allen and Dr. Corinne White is the development of a 1983 edition of the SAT-HI.

Several reasons guide the development of a new edition. The 1973 test will become outdated when the Psychological Corporation publishes a seventh edition of the Stanford in the fall of 1982. Another problem is that, in relation to the critical stratification variables, the hearing impaired norming population has changed between 1974 and 1982. For example, far more hearing impaired students now attend public schools in mainstream settings, and the proportion of minority students has increased during the past decade (Karchmer, Milone, & Wolk, 1979). Because the population of potential test takers is different, it will be necessary to develop new norms.

Eight years of experience with the SAT-HI has brought to light various issues which can be addressed in the development of a new test. The rate of progress in various school subjects by hearing impaired students differs from that of hearing students (Trybus & Karchmer, 1977). This poses a problem in testing, since no single test level is suitable for an individual child in all subjects. The 1973 SAT-HI solved this problem by recombining subtests from different levels of the regular SAT to produce the SAT-HI, based on empirical performance patterns of deaf children as a group. Although this organization was appropriate for many hearing impaired students, it did not provide an optimal grouping of tests for others.

The current SAT-HI is not sensitive enough to detect the year-to-year gains for many individual hearing impaired students. The reliabilities of many subtests of the SAT-HI have been reported in the .80 to .92 range (Jensema, 1978). These reliabilities translate to scale score standard errors of approximately three points (Wolk & Karchmer, 1980) for individuals. When one-year growth scores are computed, they tend to fall within three points or one standard error of the baseline scores.

The lack of a parallel form of the test is another limitation since many programs administer the SAT-HI repeatedly. A study in Texas found that over a quarter of the hearing impaired students took the same form and level of the test in each of three successive years.

In addition, the current screening test procedure is too long and includes only reading items. As a result, the screening test does not always correctly identify the level of the math subtest that should be administered. Separate screening tests in reading and math would remedy this problem.

Finally, certain items are unsuitable for hearing impaired students, as when some component of the item requires knowledge that is not a part of the student's curriculum. In other cases, subtest formats are not appropriate, as when the test administrator must dictate spelling words within the context of a sentence. The test instructions urge that fingerspelling be used to communicate specific words that must be conveyed unambiguously. By fingerspelling a word that the student is expected to spell, the administrator reveals the answer. Yet other, more ambiguous communication modes put deaf students at an unfair disadvantage.

The New SAT-HI

The 1983 SAT-HI contains enhancements in: 1) the screening procedure; 2) the test booklets and answer sheets; and 3) the scoring techniques.

The screening procedure is used to select the test level appropriate for a student. Separate screening tests in reading and math have been devised. These short tests, requiring no more than 30 minutes to administer, contain items selected from the original item pool of the 1982 Stanford. Both the screening test score and the item response pattern are used to identify the appropriate test level. A field test of these reading and math screening instruments was conducted in the spring of 1982, based on a sample of 1,682 hearing impaired students drawn from a random sample of special education programs throughout the country. This sample was representative of public, residential, and day school programs at both the elementary and secondary levels. Data from this field test are currently

being analyzed. (A complete description of the screening test procedure and results of the field test will be available in September, 1982.)

The 1983 SAT-HI test battery will consist of two parallel forms of reading and math tests representing six levels of difficulty, each of which is published in a separate test booklet. At the lower three test levels, the booklets will be "consumable," that is, students will mark directly on the booklets. At all levels, instructions for the dictated items will be printed in the test booklets, and ink colors for all the test booklets will be selected with the problems of visually impaired students in mind.

An additional refinement was made possible with the assistance of a group of educators of the hearing impaired. Prior to the publication of the 1982 edition of the Stanford, the group was instructed to review test items for possible bias against hearing impaired students. All of the items in the reading and math tests were reviewed by this group, and their input guided the test publishers in their final item selection.

During the regular testing dates in the spring of 1983, a large-scale nationwide field test of Form E of the new edition will be conducted. Form F, the parallel form, will be developed and equated to Form E the following year. The norming sample will consist of approximately 8,000 hearing impaired students, ages 8-19, in 350 programs.

Allen and White anticipate improvements in the reliability of the new modified test. The hope is that, with better screening procedures, flexibility in the assignment of math and reading subtests separately, the printing of dictated items in the test booklets, and the provision of "consumable" test booklets through Level III of the test, measurement error will be minimized.

New Features in Scoring

In order for score reports to meet the diverse needs of students, parents, teachers, and administrators, a computerized test scoring package is being developed which emphasizes flexibility in grouping on two levels: 1) grouping of items, and 2) groupings of students.

Test users (school officials, primarily) will be able to indicate items that are not part of their reading and math curricula. The scoring package will then exclude those items. The same system will also be flexible in terms of subtest definitions; that is, users will be able to group specific test items to create subtests meaningful to their students.

When requested, reference group percentiles for hearing impaired students can be created by state, region of the country, and demographic characteristics.

As in the past, hearing impaired norm tables will be published which represent the percentile distributions, broken down by age, of the scale scores for the national sample. For age groups which have an adequate representation of different levels of hearing loss within the group, separate tables will be created for distributions of students with different amounts of hearing loss. This norm information will be included on the score reports along with item response information, raw scores, standard scores, and norms for the hearing population.

Administrator summaries and statistical reports on group achievement can be prepared simultaneously with the student, parent, and teacher score reports. Merging the demographic and achievement data will enhance the ability of researchers to study important relationships among the deafness, demographic, and achievement variables.

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A Decade of the Annual Survey of Hearing Impaired Children and Youth: 1970 to 1980

Principal Investigators:
Michael A. Karchmer, Ph.D. and Arthur Schildroth, M.A.

In operation since 1968, the Annual Survey of Hearing Impaired Children and Youth has reached both public and private programs and has included not only schools but also speech and hearing centers, rehabilitation programs, medical units, state hospitals, and programs for the multiply handicapped. The vast majority of schools and programs contacted each year have been educational programs in the more traditional sense: residential and day schools for the deaf and full- and part-time classes for hearing impaired children and youth.

The period from 1970 through 1980, a decade plus one, provides a convenient time frame in which to review changes in student numbers and characteristics as determined through the Annual Survey of Hearing Impaired Children and Youth.

Educational Programs

Table 1 presents the number of programs contacted and the number that actually participated in the Annual Survey for the two school years 1970-71 and 1980-81.

Between 1970 and 1980 the number of programs contacted in the survey increased by 93%, with many of the larger school districts and consolidated regions reporting hearing impaired students from numerous individual schools within their boundaries. The number of children and youth reported to the survey increased by 33% between 1970 and 1980, while the rate of participation by schools contacted remained similar for the two years, 75% in 1970-71 and 73% for 1980-81. The significant increase in the number of participating programs between 1970 and 1980 was due, then, to the addition of a large number of smaller programs. The average enrollment of participating programs in 1970 was 70 students; in 1980 that average enrollment had dropped to 50; the 509 new programs had an average enrollment of 27 students. These changes reflect the proliferation in the 1970's of small, locally operated programs established in response to changes in special education policy.

There was an especially large increase in the number of students reported from the South between 1970 and 1980, an increase of over 80% or 8,682 students. This increased participation resulted in part from the two special state surveys in Texas and Louisiana begun during the 1970s. To an extent the shift also reflects the migration patterns of the general population.

Missing Data

"Missing data" refers to blanks or unusable responses to items on the survey questionnaires. One indication of the quality of survey data is the amount of missing or unusable information within the survey. Table 2 presents this missing data for those questions which can be compared in the 1970-71 and 1980-81 Annual Surveys. The most notable feature of Table 2 is the decrease, in most cases rather significant, in the amount of missing data from 1970 to 1980. School records were better kept and/or better reported in 1980.

Table 1

Programs Contacted and Programs Participating, 1970-71 and 1980-81.

	Programs contacted N	%	Programs participating N	%	Number of students in participating schools
1970	775	100%	585	75%	41,109
1980	1,494	100%	1,094	73%	54,504

Table 2

Missing or Unusable Data, 1970–71 and 1980–81

Item	1970–71 N = 41,109	1980–81 N = 54,504
Better ear average	22.0%	0.9%[a]
Ethnic background	15.3%[b]	3.3%
Age at onset of hearing loss	16.8%	5.2%[c]
Cause of hearing loss	24.6%	18.4%
Additional handicapping conditions	15.4%	2.6%

[a]Reflects students for whom neither a better ear average nor an estimate of hearing loss was reported. If only computed better ear average is considered, the missing data percent rises to 14.3%.

[b]From the 1971–72 survey (N = 42,513).

[c]An "unknown" response option was added to the 1980–81 survey, but was not on the 1970–71 questionnaire. In 1980–81, 17.2% of the records were reported as "unknown."

Age

A significant shift occurred in the distribution of students' age between the 1970 and 1980 surveys. In 1970, only 27.6% of the 41,109 students in the survey were 14 years of age or older. By 1980, that 14-and-older age group had risen to 43.8%. (Students 14 and above comprised 60% of the total enrollment in 60 residential schools across the country.) The age group "14 through 17" showed the largest age shift, from 21.1% in 1970 to 35.4% in 1980. This increase reflects the presence of children deafened as a result of the 1964-65 rubella epidemic.

The large number of hearing impaired students within the 14-17 age category will advance into the next age bracket within a few years, and the vast majority of them will leave the secondary school system. Postsecondary institutions and vocational rehabilitation agencies will need to prepare for a large influx of deaf young adults. The corresponding decrease in secondary enrollment will no doubt give rise to dramatic changes in high school programs, particularly in view of current, bleak fiscal realities.

Table 3

Age Distribution, 1970 and 1980

Age	1970–71		1980–81[a]	
	N	%	N	%
< 3 years	447	1.1%	1,162	2.2%
3–5 years	4,940	12.0%	4,691	8.7%
6–9 years	12,119	29.5%	10,894	20.3%
10–13 years	12,275	29.9%	13,486	25.1%
14–17 years	8,661	21.1%	19,021	35.4%
18 years & over	2,667	6.5%	4,533	8.4%
Total	41,109	100.0%	53,787	100.0%

[a]Age was not reported for 717 students.

Ethnic Background

Table 4 compares information on student ethnic background for the first year (1971-72) and the most recent year (1980-81) in which these data were collected. Minority students represented 21.9% of the total for whom information was reported on this item in 1971. A decade later they accounted for 30.1% of the students with known ethnic background. The number of black hearing impaired students reported to the survey increased by 83% between 1971 and 1980; the number of Hispanic students by 117%; and the number in the "other" ethnic category, the large majority of whom were from either Asian-Pacific or Native American backgrounds, increased by 247% (from 440 to 1,525), although these numbers in this "other" category were relatively small.

Table 4

Ethnic Background Distribution[a], 1970–71 and 1980–81

	1971–72		1980–81	
	N	%	N	%
White	28,094	78.1	37,088	69.9
Black	5,087	14.1	9,322	17.6
Hispanic	2,368	6.6	5,128	9.7
Other	440	1.2	1,525	2.9
Total	35,989	100	53,063	100

[a]Ethnic background questions left blank and those checked "unknown" or "cannot report" have been excluded.

There are multiple reasons for such dramatic increases. To a large degree, the figures undoubtedly mirror underlying changes in the general population. The increase in minority students may also reflect the expansion of services to larger segments of the population as a result of P.L. 94-142 and similar legislation.

Audiological Information

Table 5 summarizes audiological data from the 1970 and 1980 surveys. The degree of hearing loss is displayed in terms of a better ear average (BEA), determined by averaging the reported pure-tone thresholds in the speech range (500, 1000, and 2000 Hz) in the better ear. On the 1980 survey form, the school was given the opportunity to record an estimate of a student's hearing loss if pure-tone thresholds were not available. Thus, the 1980 data represent a combination of BEA and these estimates of student hearing level; the 1970 data are better ear averages only.

The 1970 and 1980 surveys show similar percentages of children with less-than-severe losses (< 71 dB in the better ear) although the number of such children studied increased by 72% (9,982 students in 1970 to 17,121 in 1980). Children with severe losses (71-90 dB) and those with profound losses (91 dB and over) represented somewhat different patterns: the number of children with severe losses increased by only about 28% (8,826 to 11,273) the number with profound losses jumped from 13,246 students in 1970 to 25,622 in 1980, a 93% increase. This increase is likely an artifact of the decrease in missing audiological data. That is, twelve years ago, schools may have reported no pure-tone threshold data for some students whose loss was profound, whereas in the 1980 survey they were permitted to estimate the loss.

Table 5

Audiological Data, 1970 and 1980

Degree of Loss	1970[a]		1980[b]	
	N	%	N	%
Normal (< 27 dB)	1,414	4.4%	3,219	6.0%
Mild (27-40 dB)	1,603	5.0%	3,218	6.0%
Moderate (41-55 dB)	2,533	7.9%	4,616	8.5%
Mod. Severe (56-70 dB)	4,432	13.8%	6,068	11.3%
Severe (71-90 dB)	8,826	27.5%	11,273	20.9%
Profound (≥ 91 dB)	13,246	41.3%	25,622	47.4%
TOTAL	32,054	100.0%	54,034	100.0%

[a]Better ear averages only.
[b]Better ear averages plus estimates.

Additional Handicapping Conditions

Information has also been collected on the handicapping conditions which, in addition to hearing impairment, have significantly affected a student's learning or have required modifications in the educational program. Table 6 compares the data collected on this variable during the 1970 and 1980 surveys.

The percentage of students with one or more added handicaps decreased only slightly between 1970 and 1980, from 31.4% to 30%.

Summary

Between 1970 and 1980 the number of programs contacted, those participating in the survey, and the number of students reported all increased significantly. At the end of the decade, the children and youth in the survey tended to be older, came more often from a minority background, and were more likely to have profound hearing loss than were the students in the 1970 survey. Approximately 30% of the students in both the 1970 and 1980 surveys had one or more handicaps in addition to their hearing impairment.

This documentation of the number and characteristics of hearing impaired students receiving special and regular educational services across the country has provided the foundation upon which numerous research and development projects have been built. One example of this is the development and norming of the Special Edition for Hearing Impaired Students of the Stanford Achievement Test, one edition in 1973 and the second, still in progress, in 1982-83.

Table 6

Additional Handicapping Conditions, 1970 and 1980[a]

	1970		1980	
	N	%	N	%
Total students	34,795	100.0%	53,113	100.0%
No additional handicaps	23,874	68.6%	37,202	70.0%
One additional handicap	8,556	24.6%	10,624	20.0%
Two additional handicaps	1,928	5.5%	3,365	6.3%
Three or more additional handicaps	437	1.3%	1,922	3.6%

[a]Excludes missing data from calculations: 6,314 (15.4%) records in 1970; 1,391 (2.6%) in 1980.

State Surveys of Hearing Impaired Children and Youth

Principal Investigators: Michael A. Karchmer, Ph.D. and Brenda Rawlings

As public agencies have sought to expand appropriate educational services to handicapped children, so has the need grown for extensive, in-depth information about these persons, the services they are receiving, and the learning outcomes of these services.

The state departments of education in Texas, Louisiana, and Nebraska sought assistance in the collection of detailed demographic information on their handicapped student populations. A contractual arrangement with the Texas Education Agency (TEA) to collect information on the hearing impaired students who are attending the Regional Day School Programs for the Deaf and the Texas School for the Deaf has been in operation for six years. The Louisiana State Department of Education has been involved for four years in the study of their handicapped students. During the first three years of the project hearing impaired and deaf-blind children in the state were included, while in 1981, the scope of the project was expanded to include visually handicapped children. All sensory impaired children (hearing impaired, deaf-blind, and visually handicapped) have been studied in the Nebraska State Survey since its inception two years ago.

The development of the projects has been a collaborative effort, as each state agency has tailored the system to meet its specific circumstances. The general data sought in all three projects relate to age, sex, race, etiology of the visual or hearing handicap, severity of impairment, and additional handicapping conditions. Agencies also report the type of regular and/or special classroom placement and special services provided (if any) for those children in mainstream classrooms.

Each year, education agencies complete an individual questionnaire ("student profile") on each student. In Texas and Louisiana, the information is supplied by the school or program actually providing the special education services. In Nebraska, the local education agency of the family's residence provides the information. If, for example, a child's family resides in Lincoln, but the child is attending the Nebraska School for the Deaf in Omaha, it is the Lincoln public school system that reports the child to the survey rather than the school for the deaf.

Measures of the academic achievement of hearing impaired children have been obtained through the administration of the Stanford Achievement Test, Special Edition for the Hearing Impaired (SAT-HI). Orientation workshops and instructional materials are provided to the educational personnel who administer the tests. The computerized demographic information is then combined with the assessment data to prepare individual student score reports and various other analyses.

The completeness of the data varies by state. Texas has the highest agency participation rate of the three projects, probably because the regional day schools are required by the TEA to participate in the survey, and because the project has been in operation for six years. In both Louisiana and Nebraska, where participation is voluntary (although strongly encouraged by the State Department of Education), response has increased with each year of operation. Table 1 indicates the number of agencies providing information and the number of children reported in each of the three states during the 1980-81 school year.

Table 1

Participation in State Surveys, 1980–81

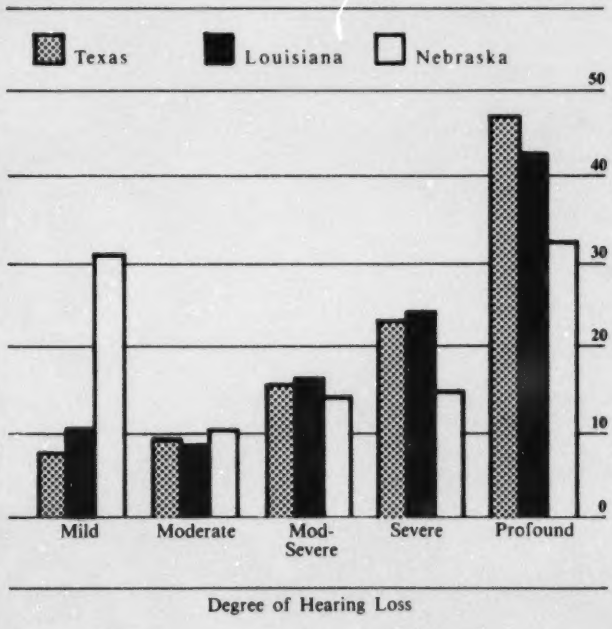
Population	Number of agencies submitting data	Number of children reported
Texas		
Hearing impaired only	77	4,298
Louisiana		
Hearing impaired and deaf-blind	54	1,654
Nebraska		
Hearing impaired, visually handicapped, and deaf-blind	161	844

Assessment and demographic variables have been analyzed in a number of research studies. One study provided a means for verifying the audiological data collected and allowed the TEA to evaluate appropriateness of student placement. Agency staff noted that 136 children whose reported hearing level was less than 27 dB in the better ear were in special education programs for the hearing impaired. TEA reviewed these students' cases individually. In 95% of the cases, the audiological information submitted was accurate and, where program placement was not appropriate, children were subsequently placed in less restrictive environments.

Figure 1 shows a comparison of the distribution of audiological information in the three states. In Texas and Louisiana the distribution of hearing losses is remarkably similar, while the Nebraska results indicate a larger proportion of students with less severe losses. This difference is a function of the reporting procedures followed by Nebraska, where the local education agency provides the information regardless of where the child is served. Because of its design, the Nebraska survey is locating a larger proportion of children who are less severely hearing handicapped and are served in regular classroom settings.

A follow-up project with the Kresge Hearing Research Laboratory of the South is being conducted in an attempt to determine the predictive abilities of auditory brain stem response tests. Recent audiograms are being examined to verify the existence of hearing impairments in children earlier diagnosed via auditory brain stem response tests. Over 200 children are being studied.

Figure 1
Distribution of Hearing Loss for Students in 3 States 1981-82



Hearing Impairment/Visually Impaired

Information on visual impairments has always been a topic of interest in demographic studies of hearing impaired children. However, only limited information has been available until recently, when the Nebraska and Louisiana studies expanded to include visually handicapped populations. The 1981-82 data are presently being tabulated and will soon provide the basis for cross-state comparisons. It is already known that 3% of the hearing impaired students in Louisiana are diagnosed as having Usher's Syndrome; this is a much higher rate than the less than 1% prevalence found elsewhere in the nation. This special population of children will be the subject of further study.

Longitudinal Studies

The numerous years of data collection in Texas have provided the opportunity for longitudinal studies of the academic achievement of hearing impaired children there. Achievement test scores for students tested in three consecutive years have been analyzed and some highlights of the data are found in Table 2. Younger students acquire computation skills at a faster rate than do older students, while the latter acquire reading comprehension and math concepts skills at a faster rate. White students perform better than do both black and Hispanic students in reading comprehension, math concepts, and math computation. Males and females showed virtually identical growth patterns. In reading comprehension and math concepts, students with severe hearing loss showed more growth than students with profound loss.

In an attempt to verify the appropriateness of the SAT-HI for use with the hearing impaired children in Texas, SAT-HI test items were matched with the Texas Statewide Curriculum for the Deaf. This was done to determine the extent to which the test content was actually part of the curriculum being taught in the schools. On the average 93% of the SAT-HI items at each level of the math application, computation and concepts subtests were found to be part of the Texas Statewide Curriculum. A preliminary analysis on item responses also has identified those test items typically missed which were not part of the curriculum. This situation accounts for slightly less than 12% of the errors.

Table 2

Mean Growth Scores* (1978–1980) on Three SAT-HI Subtests as a Function of Various Demographic Characteristics, Texas

Characteristics	Reading comprehension	Mathematics concepts	Mathematics computations
Entire state of Texas	8.7	15.5	16.2
Age in 1978			
8– 9 years old	9.1	15.5	19.4
10–11 years old	8.3	16.0	17.9
12–13 years old	8.2	14.4	15.6
14–15 years old	8.8	15.6	13.4
16–17 years old	10.8	18.3	15.0
Race			
White	10.3	16.6	17.2
Black	6.8	12.4	14.5
Spanish-American	7.4	15.5	15.6
Sex			
Male	8.7	15.7	16.4
Female	8.8	15.4	16.1
Level of hearing loss in 1980			
Less-than-severe	10.2	16.5	16.3
Severe	8.6	16.2	15.9
Profound	8.2	14.8	16.5

*Computed by subtracting the scaled scores obtained in 1978 from those obtained in 1980 for each individual, then computing mean difference scores for each group.

Although state-specific data has somewhat limited generalizability, the breadth of information developed on nearly complete populations has important ramifications for substantive research. Some such questions are:

What are the decision-making, fiscal, legal and demographic factors which underly special education placement?

What are the patterns of movement in and out of special education programs for such a population?

How do special education services interface with other social and medical services available to sensory impaired children?

The three state surveys have provided a wealth of information for in-depth research projects in various subject areas. Similar opportunities in other states will be pursued in the future.

The Autocuer

Principal Investigators: R. Orin Cornett, Ph.D. and Robert Beadles (Research Triangle Institute)

For more than ten years Dr. R. Orin Cornett has collaborated with scientists at the Research Triangle Institute on the development of a speech-analyzing lipreading aid based on the principles of Cued Speech, called the Autocuer. The Autocuer project, in recent years funded by the National Aeronautics and Space Administration and the Veterans Administration, is now nearing the field-test stage.

The Autocuer is designed to provide the equivalent of the cues of manually-cued speech, operating automatically from the sound of the speaker's voice. The cues are seen as virtual images in the air, a few feet in front of the wearer, who can by positioning his head place images of the cues on or near the face of the speaker, near the lips. It is anticipated that the field test model will be the size of a small book, and that the production model produced subsequently will be in the bows of the wearer's glasses.

The device uses a microphone-generated signal which is filtered, preshaped, and delivered to a computer that samples five parameters 12,500 times per second and sums them each 10 milliseconds. It uses the resulting data to segment the speech string into phonemes, assign them to cue groups, and drive the display in real time, approximately 150 milliseconds behind the sound pattern. The output of a linear prediction program furnishes some of the discriminations on which the basic (zero-crossings and energy analysis) program is weakest.

If moderately successful in terms of accuracy and reliability, the Autocuer will make life simpler and easier for the deaf person who wishes to function in the hearing world for an appreciable part of his time. If it is highly successful, it promises to enable many more deaf persons to communicate more freely with hearing people.

Training and Testing

To date over 100 college subjects and seven older subjects have been trained and tested over a period of five years on both a simulated (corrected) output and the actual output of the speech analyzer. Subjects have been trained initially on the simulated material, to establish an upper limit for the potential contribution of the device to lipreading accuracy. The last group of subjects (n = 6), averaging 13.3 hours of training on the basic code, have been able consistently to read randomly selected consonant-vowel syllables at an accuracy of 86.5% to 99%, above the range (80% to 95%) for normally hearing subjects using audition. The two subjects already skilled at receiving manually cued speech achieve the same level in approximately five hours.

Approximately 45 hours of training on 500 of the most frequently used words in the English language enabled the subjects to read random samples of these words (perfectly cued) at an accuracy of 78% to 91% (average, 85.5%). During the period of their training and presumably as a result of it, their average scores on unaided lipreading of randomly selected words from the same 500-word set, without the cues, increased from 35.3% to 55.8%. This difference is statistically significant at the 99% confidence level, even for the small group of subjects (six) trained in the last year of testing.

One of the problems inherent in the speech analysis program is that its accuracy is much lower for isolated words than for connected language. This is primarily because the duration of an initial stop in a word is indeterminate if it is initial in the utterance.

Because it was not possible to schedule Gallaudet students for more than two to four hours of training per week, and because practically all had limited knowledge of spoken language, there was not enough time to get the subjects to the level of skill required for processing running language. This, of course, is why a field test with a wearable unit is necessary.

The last group of evaluations made with Gallaudet College students (November 1980-May 1981) was especially significant, because these tests were needed to evaluate the probable merits of several different options in the final choice of design for the speech analyzer. These options included: (1) the use of the already-designed program using a combination of rms energy and zero crossings for both segmentation and phoneme classification, (2) the use of rms energy and zero crossings for segmentation plus a combination of linear prediction and zero crossings for classification,

and (3) each of the above with more stringent "go/no-go" requirements (giving no cue in a case in which error probability is high).

Videotapes were made of a speaker using cued speech. Errors and omissions were included in the tape according to the anticipated performance of a mature speech analyzer employing a combination of rms energy and zero crossings for segmentation plus a combination of linear prediction and zero crossings for classification. The estimated cue group assignment

Table 1

Effects of Error Adjustment

Subject	Cued (12/80)	Cued (4/81)	Change
	Analyzer output, zero crossings only	Zero crossings analyzer output, error adjusted	
1	56%	63%	+13%
2	65%	—	—
3	71%	—	—
4	56%	67%	+20%
5	52%	62%	+19%
6	72%	75%	+ 4%
Average	62.0%	66.8%	+ 8%

Subject	Cued (4/81)	Cued (5/81)	Change
	Analyzer output, zero crossings + linear prediction	Zero crossings + linear prediction analyzer output, error adjusted	
1	71%	75%	+ 6%
2	—	—	—
3	—	—	—
4	74%	83%	+12%
5	80%	87%	+ 9%
6	82%	83%	+ 1%
Average	76.8%	82.0%	+ 7.0%

accuracy for the combination analyzer was 80% correct, 11% errors of commission (wrong cues), and 9% errors of omission (no cues). This accuracy estimate may be compared with the zero crossings/energy analyzer accuracy: 69.5% correct, 21.4% errors of commission, and 9.1% errors of omission.

The data on subject performance (see Table 1) suggest several conclusions:

1. The average score for the four subjects using the predicted performance of the combined zero crossings-linear prediction model, was 82% on random selected isolated words. The difference between this mean and that for unaided lipreading is ($t = 5.49$) significant at approximately the 99% confidence level. Taken at face value, this would suggest that subjects well-versed in spoken English (as will be the subjects of the field test) may be expected to understand running conversation in familiar language, unless there is some problem with the speed at which the visual input can be handled. There seems to be no such problem with manually cued speech. However, there are several complicating possibilities. For example, the estimated cue group accuracy of the output (80% correct, 11% wrong, 9% omitted) may be higher or lower than the actual performance.
2. The average score with the zero crossings and rms energy program, 62%, is only slightly higher than the unaided lipreading score after training. The high error rate of this analyzer model is thought to be the problem; subjects repeatedly complained that the errors confused them.
3. By applying more stringent conditions to be satisfied before a cue is given, the program can replace many errors of commission with errors of omission. Subjects performed better under this condition. The difference between the average score without error reduction (76.8%) and with (estimated) error reduction (82%) is significant ($t = 3.00$) at the 94% confidence level, suggesting that the final design should include error reduction through "no-go" conditions. However, this difference may be offset by the ability of the subjects, once the wearable units are available, to learn the patterns of frequent errors. For example, they might learn that a given sound is cued correctly 60% of the time, but that when it is cued wrong the error is usually consistent.

Upon completion of the wearable prototypes and subsequent manufacture of the first autocuers, pre-testing and field training will begin.

How Effective are Cochlear Implants?

Principal Investigator: William McFarland, Ph.D.

Recent years have seen rapid growth in the use of "cochlear implants" as an attempt to restore hearing. These surgically-implanted processors translate sound into electrical signals that stimulate the auditory nerve. If the hearing impaired person has no damage to the auditory nerve or the central nervous system, the signals result in the perception of sound. Users of the electro-auditory implants generally report a greater awareness of sound; the actual usefulness of the sounds they perceive, which are not the same sounds heard by the normal ear, seems to vary from person to person.

An important issue is whether the cost and the risk involved in electrical implants compares favorably with the benefits to the hearing impaired person. Of particular interest is the practicality of the implants when compared with other assistive devices, such as vibrating stimulators that represent voice sounds on the skin.

A study now underway will evaluate the effectiveness of a single auditory-electrode system in restoring usable hearing. The multi-year evaluation is a collaborative effort between the GRI's Rehabilitation Engineering Center and Stanford University, where engineers developed the implant device. The study will begin with the selection of hearing impaired patients to be implanted with Stanford's programmable, single auditory-electrode system. Subjects of the study will be recently-deafened persons who are unable to benefit from amplification through a conventional hearing aid. The criterion for determining "inability to benefit" will be the subjects' inability to understand single words through audition alone. The selection procedure will include interviews with each candidate and significant other family members, a complete audiological evaluation, a complete medical examination, a detailed otological examination, a psychological evaluation, and an orientation program. In addition, one to two weeks prior to surgery, each candidate will be screened with electrical stimulation tests. The loudness judgments and amplitude functions of electrical auditory brain stem responses will serve to confirm the presence of a sufficient number of intact nerve fibers to warrant implant surgery.

Following the surgery, subjects will receive training in the use of the device and will undergo repeated hearing evaluations. The training procedure will consist of an initial forty-hour training program, followed by one to two hours per week of training for two years. With the goal of adapting a rehabilitation training program for use in this study, McFarland has examined existing aural rehabilitation programs designed for persons with electro-auditory implants.

At intervals of three to four months, subjects will be retested to determine improvement. Commonly used audiometric tests such as speech discrimination or reception tests yield little useful information on the speech perception of severely to profoundly deaf individuals. Owens et. al at the University of California, San Francisco have developed a battery of tests to assess the use of residual hearing in this population. This battery, the Minimal Auditory Capabilities (MAC) Test, has 14 subtests that assess hearing at the segmental and supra-segmental levels. Because little normative information is available on profoundly deaf individuals' performance on the MAC, it is necessary to conduct a study to supply such data in preparation for its use on implant patients. McFarland is examining MAC subtest results in relation to the following subject variables: age, degree of loss, configuration of loss, age at onset, duration of loss, age at which amplification was first used, number of years amplification has been used, current use of hearing aid (hours per day), self-perceived benefit of hearing aid, self-perceived usefulness of residual hearing, intelligibility of speech, educational background, and etiology. Results of the study will enable more meaningful interpretation of the MAC and will assist in determining what constitutes "aidable hearing" as opposed to "unaidable hearing."

Other institutions participating in the study include Baylor College of Medicine, Albert Einstein College of Medicine, Kresge Hearing Research Laboratory, Massachusetts Eye and Ear Hospital, and the University of Washington School of Medicine.

Additional Research Projects

In addition to the studies described elsewhere in this report, the following research projects were conducted during 1981-82. The name of the principal investigator appears in parentheses following the project title. A few projects are collaborative efforts with other institutions. In cases where the principal investigator is not a member of the Gallaudet Research Institute, the person's institutional affiliation is also indicated.

Education and Human Development

The development of communicative skills and the construction of social identity by pre-school deaf children through interaction with deaf and hearing adults (Erting)

A study of the effects on comprehension of two treatments (simplified versus original) of prose materials for deaf middle school readers (Ewoldt)

The development of literacy, cognition, and language in preschool hearing and hearing impaired children, as exhibited by early print-related and drawing behavior (Ewoldt)

A descriptive analysis of reading behavior exhibited by hearing and hearing impaired children (Ewoldt)

Vocabulary Frequency and Typicality Norms (Getson)

Analysis of Pre-College curriculum at MSSD (Getson)

An exploratory study of the semantic processing networks of deaf adolescents (Getson)

Survey of achievement testing in programs for the hearing impaired (Getson)

Development of an objective measure of family communication (where family includes a deaf child) (Guterman)

Cognitive processing: research in spatial ability (Hauptman)

Learning characteristics of deaf children: psycho-physiological studies (Uno)

Studies of the interaction of mothers and their deaf children (Meadow)

Studies of classroom interaction (Kluwin)

Longitudinal, multi-national research on deaf children—Planning phase (Meadow, Moores, Dyssegaard)

Discipline and classroom management in secondary school classes in residential schools (Kluwin)

Evaluation services for MSSD (Knight)

Narrative Schemata in Hearing Impaired Children (Knight)

Expansion and maintenance of the Signed English system (Bornstein)

The development and evaluation of Signed English readers (Bornstein)

Language and Communication

A demographic survey of interpreters (Cokely)

Interpreter performance study (Cokely)

Simultaneous communication and interpreting: an effectiveness study (Cokely)

Perception of complex auditory stimuli by the deaf (Pickett, Revoile)

Modification of speech production of deafened persons through the use of computer-based visual articulatory displays (Hasegawa)

Technical information service on in-place or off-the-shelf technology for hearing impaired persons (Fellendorf)

Design and evaluation of wearable spectral tactile speech aids (Nathaniel Durlach, Massachusetts Institute of Technology)

Design and evaluation of vibrotactile pitch aid for the deaf. (Moise Goldstein, Johns Hopkins University)

Evaluation of physiological glottal sensor for speech training (Mahshie, Hasegawa)

Research on speech-cue diagnostics and learning (Revoile)

Demonstration and evaluation of the effectiveness of Cued Speech in a tonal language (Cornett, Tammasaeng)

Speechreading development in deafened adults through videotaped materials in Cued Speech (Cornett, Neef)

Demonstration and evaluation of English language development in young adults through Cued Speech (Cornett)

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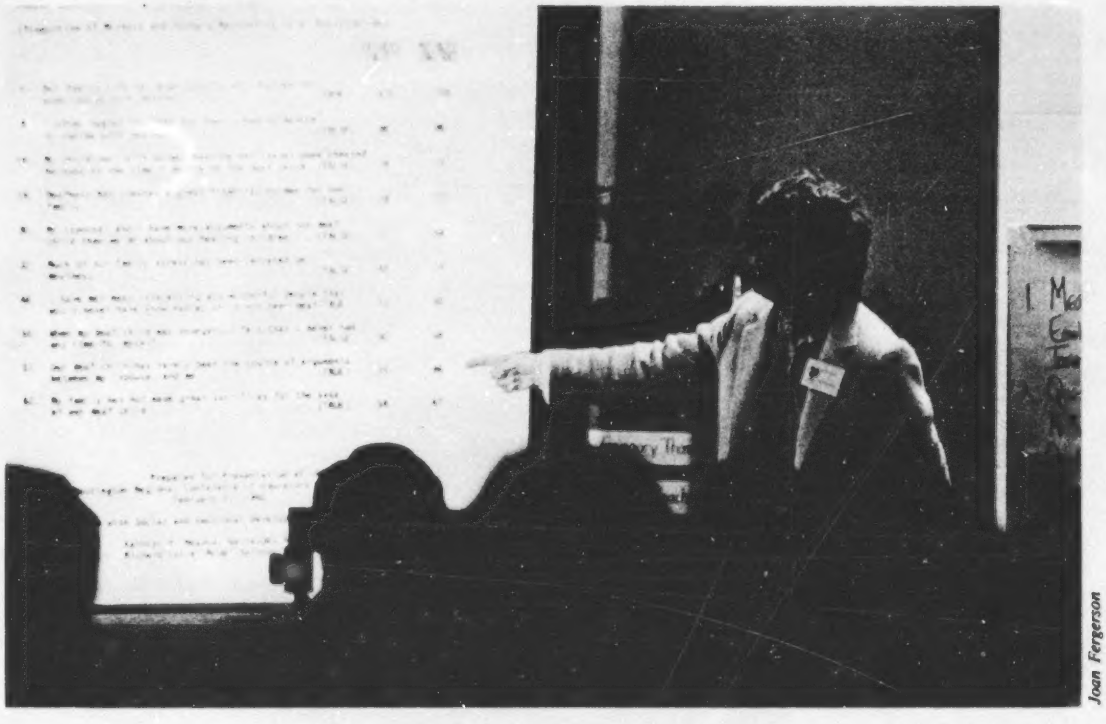

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